



Conveying Warnings and Public Response

Mitigating Potential Errors in Spotter Reports

Warning Decision Training Branch



Welcome to this short module on mitigating potential errors in spotter reports. This lesson, which lasts approximately 20 minutes, discusses how NWS offices receive spotter reports, the groups of people who submit reports, and some simple ideas on mitigating common errors that can sneak into reports. My name is Andy Wood, and I will be presenting this material.

Learning & Performance Objectives

Learning Objectives

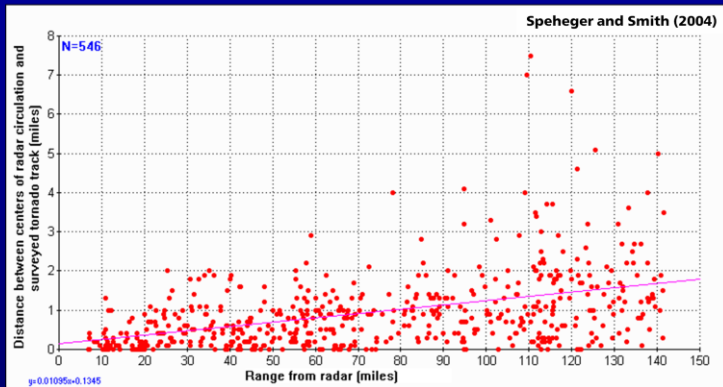
1. Identify the sources of storm reports (i.e., how they are received and from whom) as well as their strengths and weaknesses
2. Identify common storm report errors and how they occur
3. Identify the mitigation steps discussed to reduce potential errors in warning operations

Performance Objective

1. Demonstrate the ability to mitigate erroneous spotter reports in warning operations

There are three learning objectives and one performance objective for this lesson. Please take a few moments to review these objectives before proceeding to the next slide.

Spotter Reports: Vital Ground Truth Data



- Radar and spotters crucial in warning ops
- Radar data have limitations
- Spotters help overcome those limitations

Anyone even slightly familiar with NWS warning operations knows that spotter reports are important. While all observational data have value, radar data and spotter reports are heavily weighted during warning operations. Radar data, with all of its benefits, do have some significant limitations. For example, the graphic shown is from a study comparing radar circulation locations to tornado damage. The pink line indicates that the further a tornado is from the radar, the greater the error present in the radar observed location (Speheger and Smith, 2004).

Spotters are the forecasters eyes and ears in the field and help overcome some of radar data's limitations. On one hand, they provide ground truth data as critical as any mechanical sensor. On the other hand, they are people communicating their observations. To make the most of this vital data, NWS staff must use their meteorological knowledge and people skills to quality control these data just as you would from any other "sensor".

Spotter Reports: How You Receive Them as Important as Who Provides Them

"Push"
On-line Reports



Vs.

"Pull" & "Push"
Phone Calls



During warning operations, you want to balance the benefits of each



Ham Radio



Before we discuss the individuals who provide you with spotter reports, let's talk for a moment about the ways you receive these reports. After all, how you receive the information can be just as important as from whom you receive it.

Many reports come into your office through contact initiated from a spotter (or other partner). These reports can come in as a just text via an electronic reporting tool, such as E-spotter, or they can be accompanied by pictures or video (like a TV report). Either way, the information is pushed into the forecast office by the spotter (or partner). While these "push" technologies are an indispensable help for forecasters, these tools don't always provide you with the information you need, or want.

When a forecast office has to solicit reports from spotters, it requires more effort to get the information. However, if you "pull" the specific information into the office this way, you are more likely to get the information you are looking for. The more common tools forecasters use to contact spotters and partners (NW5Chat, Ham radio, and phones) also have the benefit of being two-way forms of communication. In other words, they are both push and pull tools. When you contact someone in one of these ways, it's easier to have a conversation, ask follow-up questions, and clarify what it is they are observing.

During warning operations, you'll ideally want to achieve a balance between the benefits of both "push" and "pull" technologies to receive pertinent storm information in as efficient a manner as possible.

Spotter Reports: Network Composition



In many ways, the spotters in your county warning area are just like any other surface observing network. Of course, unlike other surface data sources, spotter networks are composed of observers with a variety of experience and skill levels. These different observers fall into four general categories:

- Local spotters (including emergency managers and public safety personnel) trained by the NWS;
- Other “experienced” spotters, including storm chasers, researchers, and other weather enthusiasts in the area due to the severe weather potential;
- Various media (i.e., TV and radio) personnel reporting on severe weather and its impacts; and
- The general public.

On the next slide, you will see a breakdown of the pros and cons of observations provided by these different groups.



Sources of Spotter Reports

Process - 4 Steps (Including Introduction)

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Possible Spotter Report Significant Errors: Poor Observations

Someone looks out their south window and sees this...



If the same person had looked to their west they would have seen this...



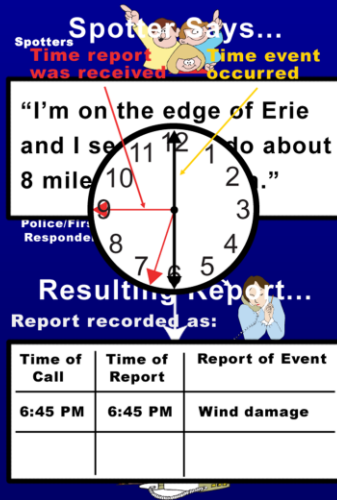
- Result from:
 - Honest mistakes
 - Lack of weather knowledge
 - Other reasons
- Conditions for observing phenomenon less than ideal
 - Remote, rain-wrapped, or nocturnal tornadoes
 - Distant objects can be mistaken for tornadoes

We've discussed how you receive reports and the people that provide them. Now let's discuss some of the common sources of errors, starting with poor observations.

Poor observations can result from either honest mistakes, a lack weather knowledge, or other reasons. In some cases, these errors result from spotters who don't know what they are looking at, or for, when severe weather is occurring. Not knowing where to look, or what to look for, can result in missing the important details.

Other reports are poor because clearly observing the phenomenon is not possible. Remote, rain-wrapped, and nocturnal tornadoes are examples of this problem. Smoke plumes, smoke stacks, or even grain silos in the vicinity of a storm can confuse a spotter about what they are really seeing.

Possible Spotter Report Significant Errors: Poor Communication



- Communication failure
 - The more people in the chain, the greater chance of error
 - Direct communication clearer, better
- Location swapping
 - GPS information can help avoid this problem
- Time swapping

Communication problems can also introduce errors into spotter reports. As with poor observations, almost anyone can make these mistakes.

The biggest problems result from reports that are relayed through an intermediary. Reports that go through multiple parties before getting to the NWS are only as good as the weakest communicator in the chain. All it takes is one communication failure and the error propagates through to your WFO. It's human nature for us to paraphrase, especially when we are busy and repeating information constantly. Anyone can make this mistake. If you ever played the game "telephone", you know what I'm talking about.

Location error is another possible communication problem. When spotters report a location, is that location where they are or where they observed (or think) the phenomenon is occurring? This problem is more likely when a spotter reports weather at a distance (e.g., tornado) and less likely when a spotter reports damage or an in situ measurement (e.g., hail measured with a ruler). However, location errors are still possible in these latter cases. Even when a spotter provides their location and the phenomenon's location, this information can get swapped somewhere down the line.

Time errors occur in a similar fashion to location errors. In haste (either the spotters or the forecasters), the occurrence time of delayed reports may occasionally be omitted. In these cases, either the time the call was received or the time of an adjacent report may be recorded instead.

Possible Spotter Report Significant Errors: Just How Many Are There?

Hail Reports (in CSV format)							
Time	Size	Location	County	State	Lat	Lon	Comments
1230	75	WARREN	BRADLEY	AR	3361	9207	(LZK)
1322	100	MARSHALL	HARRISON	TX	3254	9435	HAIL FELL JUST SOUTH OF THE HARRISON COUNTY AIRPORT ALONG HWY 31 JUST NORTH OF INTERSTATE 20. (SHV)
1409	88	SHREVEPORT	CADDO	LA	3247	9380	TV STATION REPORT IN DOWNTOWN SHREVEPORT (SHV)
1613	75	COLFAX	GRANT	LA	3152	9271	(SHV)
1615	88	HORNBECK	VERNON	LA	3133	9340	REPORTED BY VALLEY ELECTRIC. (LCH)
1705	75	DEVILLE	RAPIDES	LA	3135	9216	(LCH)
1725	75	JONESVILLE	CATAHOULA	LA	3162	9183	(JAN)
1750	100	HATHAWAY	JEFFERSON DAVIS	LA	3035	9267	(LCH)
1751	88	3 WSW DUPONT	AVOYELLES	LA	3092	9199	HIGH WINDS ALSO REPORTED (LCH)
1809	88	SIMMESPORT	AVOYELLES	LA	3098	9181	(LCH)

- It's difficult to know for sure
- Conservative estimate: at least 10%
- Witt et. al (1998): ~30% in common severe weather areas

While the errors discussed here are not all-inclusive, they can result in the more common storm report problems. So let's ask the question you are probably thinking at this point: How many spotter reports have significant errors? The honest answer is we don't know. As a result of conversations with multiple WFOs, the minimum rate of significant reporting errors is somewhere around 10%. However, the research on this subject has been limited. One study, Witt et. al (1998), indicated the number could be as high as 30% in areas of the country that regularly experience severe weather.

Common Spotter Problem #1: Observing Nocturnal Tornadoes



- Cloud features misidentified by some
- Problem magnified at night
- Lightning often best light source
- Power flashes \neq tornado

Now let's discuss some common situations where spotter problems may arise.

Regardless of a spotter's experience level, it's difficult to identify cloud features at night. Many well-meaning folks have interpreted low-hanging scud cloud as a rapidly rotating wall cloud, funnel, or even a tornado. Educating spotters eliminates these problems during the day, but there's usually not enough light to consistently see the features in nocturnal storms. Many times, the best source of light will be from lightning. Power flash reports can also help identify the location of a tornado. However, some spotters tend to think the power flashes are definitive proof of a tornado. Unfortunately, power flashes, or arcing lines, can occur in strong straight line winds, or even strong inflow winds.

Common Spotter Problem #2: Distance to Tornado Location

- Difficult to gauge distance
- Lack of reference points
- Actual distance double (or more) of estimate

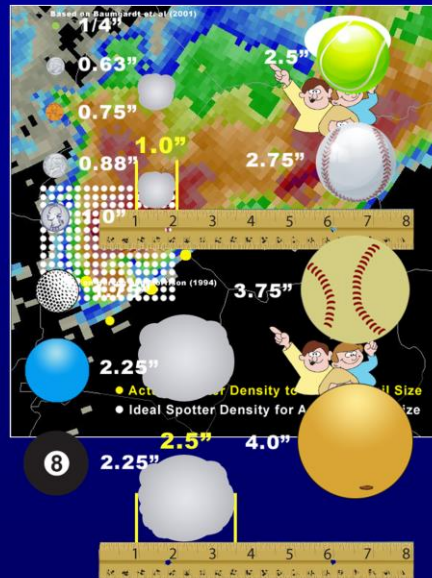


Regardless of time of day, people have a difficult time gauging their distance from storm features. Even experienced spotters will use some sort of correction of their estimate based on their personal knowledge. Objects at a distance, especially those in the sky, appear closer than they actually are when there are no reference features to provide context. When a spotter provides an estimate of a tornado location several miles from their location, expect the estimate to have some error.

In these cases, it can be helpful to know a spotter's location. If you have multiple wall or funnel cloud reports observed from a distance, then the spotter locations (along with the direction they are looking) can help you triangulate the location.

Common Spotter Problem #3: Accurate Hail Sizes

- Spotters density
- Significant time & location errors
- Spotters underestimate small hail
- Positive size bias possible for large hail
- Without ruler, spotters most accurate comparing hail size to objects

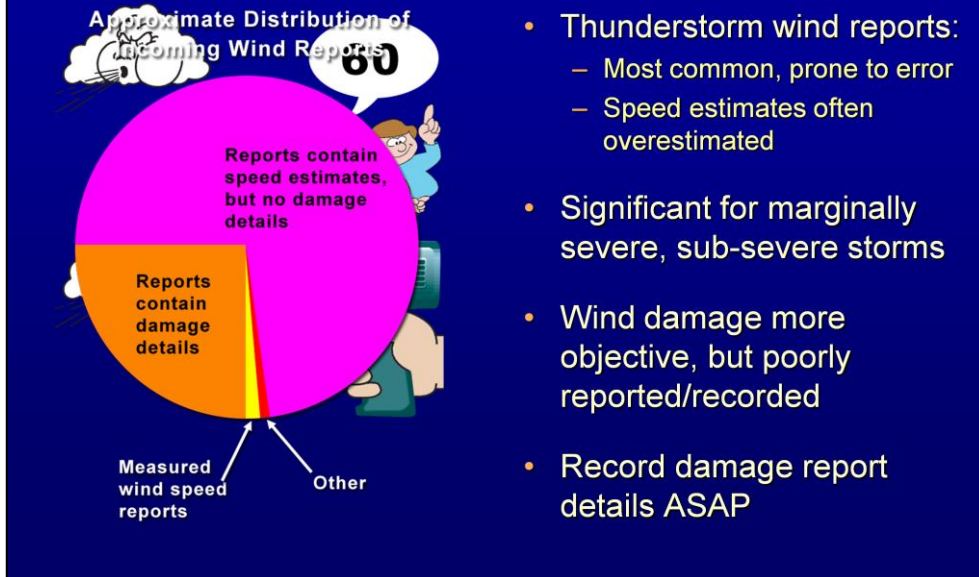


Spotter reports of hail size have several potential issues. For starters, your spotter density will usually be less than ideal to accurately measure hail size in a thunderstorm (which is approximately one observer per square mile; Changnon, 1968). Time and location errors for hail can occur frequently, up to one-third of the time in some cases (Witt et al. 1998). Recent efforts, such as the SHAVE project, have attempted to better measure and verify hail sizes in some areas of the country, but it's difficult to know if this error rate has improved significantly over the last decade.

Errors related to hail size are often a result of spotters not measuring the stone size with a ruler (or similar measuring tool). Lacking an objective measurement, a study conducted through the NWS LaCrosse, WI office (Baumgardt et al., 2001) found that spotters tend to underestimate the size of hail smaller than golf balls. At larger sizes, the bias is less significant, but the size estimates vary greatly. A study by Herzog and Morrison (1994) found that there may be substantial bias towards larger hail stones in Storm Data. While these conclusions don't agree completely, one can conclude that it's easier to get significant overestimates on large hail vs. small hail.

In a follow up study, the NWS LaCrosse, WI office (Baumgardt et al., 2002) found that spotters are more accurate identifying hail size compared to an object (e.g., egg, golf ball) if they don't have a ruler. While this process can cause hail reports to cluster at certain object sizes, including golf ball and baseball (Edwards and Thompson, 1998), the reports are more accurate than trying to estimate the size in inches.

Common Spotter Problem #4: Lack of Wind Speed Damage Details



Strong winds from thunderstorms are often the most common severe weather threat reported. Unfortunately, wind speed estimates from these storms are very susceptible to error. While spotters do their best, they tend to overestimate wind speeds (LaDue, 2003). This issue is most significant for storms with marginally severe or sub-severe thunderstorm winds.

Unlike speed estimates, damage reports result in an objective impact. Unfortunately, wind damage is either not well reported (or well documented) at WFOs. From a small sample of severe weather events, we found that reports in phone logs generally contained an indication of wind damage in only 1 in 5 reports. Similarly, the climatological record of thunderstorm winds lack detailed records of damage for $\frac{3}{4}$ of reports (Weiss and Vescio, 1996). While these numbers have likely improved somewhat in recent years, a lack of damage details is still a concern.

When damage is reported, it's often tree damage. Using due diligence, you can often determine the level of tree damage in first hand reports. While warning operations are time sensitive situations, do your best to document the details of the report. When working an event with numerous reports, you are likely to forget, or confuse, the details of a specific report in a few minutes.

Common Spotter Problem #5: Climatological vs. Real-time Snowfall Obs

- An issue in WFOs that often experience convective snow events
- Timing of observations is key difference
- Climate obs:
 - Every 6 hrs to 1/day
 - Included in local climate record
- Real-time obs:
 - Every 1-6 hrs
 - Help determine snow intensity & event duration
- When compared, real-time obs will overestimate snow totals

Real-Time Observations

Location	Time	Amount
Circleville	7:00 AM	1"
Circleville	8:00 AM	0.5"
Circleville	9:00 AM	2.0"
Circleville	11:00 AM	3.3"

Climatological Observations

Location	Time	Amount
Circleville	6:00 AM	5.1"
Circleville	12:00 PM	1.1"
Circleville	6:00 PM	0.3"
Circleville	12:00 AM	0.0"

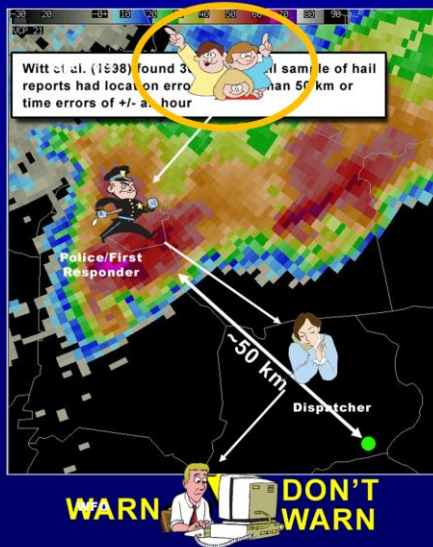
And now for a problem you might not have thought about being in this lesson. In several forecast offices, especially those prone to convective snow events with strong intensities, there are two different types of snow measurements that they receive. These snow measurements can be classified as either climatological or real-time. The difference between the two is in the timing of the observations (NOAA, 1997).

Climatological snowfall observations, are taken anywhere from once a day to every 6 hours. These reports should include new snowfall, snow depth, and liquid equivalent and are added to the climatological record of snowfall.

Real-time snowfall observations are taken more frequently, usually on the order of once every 1-6 hours. Real-time observations provide the warning forecaster more precise information on snow intensity and event duration. Real-time observations, because they are so frequent, don't allow new snow enough time to settle. The resulting measurement will overestimate snow accumulations when they are compared to climatological observations.

If you utilize real-time snowfall measurements, you should educate your local media to avoid comparing real-time and climatological snow totals. If significant deviations occur between your official totals and those in media reports, public confusion (and a few angry phone calls) may result.

Mitigation Efforts: Some Simple Steps You Can Take



- Maintain good SA
- Use radar, other data to verify report location & timing
- Indicate in records whether reports 1st or 2nd hand
- Take the time to clearly indicate a reports source

Now let's move on to some simple mitigation steps you can take in your office.

For starters, maintain good Situation Awareness (SA). You likely cannot quality control every spotter report as it comes into your office. With good SA, most reports with significant problems will be obvious right away.

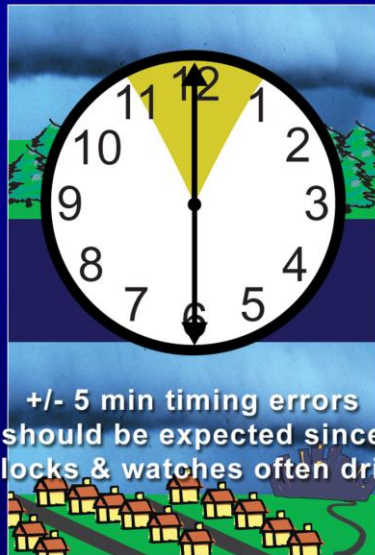
If you suspect a report is suspicious, use radar and other data to match the report to what you are observing. This step can be conducted in real-time, regardless of how the information was received. Location or timing errors can be identified best through this data comparison. During post-event analysis, we recommend you compare all of your reports (not just suspicious ones) to radar data.

Whether or not a report seems suspicious, note whether the report is direct from the source or relayed through someone else. During a significant event, even experts at relaying information from others may get confused, mix up information, and misread report locations and times. Knowing which reports are 2nd hand can come in handy at a later time during the event if a question arises.

Lastly, indicate clearly a reports source in your office notes. Report quality will vary based on both who made the report and where they live. Where NWS-trained spotters are plentiful, they will report on events 80% of the time or more. In areas where spotters are sparse, the chances are closer to 30% (Baumgardt, 2004).

Following these steps will not catch every bad report, but it should help.

Mitigation Efforts: Some Questions to Ask Yourself?



- Is the spotter seeing or experiencing the event?
- Is there only one report?
- Are there any non-meteorological factors at play?
- What time do you have?

Here are some other questions to ask yourself (or the spotter):

Are they seeing the phenomenon, or are they experiencing the event? Seeing a tornado is one thing, but having your home damaged or destroyed by one is another. Our eyes can be deceived much easier by events at a distance than by more material evidence nearby (such as physical damage).

Is there only one report? A single, uncorroborated report is more likely to cause decision-making problems in your office. To put this issue into perspective, one out of six tornadoes reported during the May 3rd tornado outbreak in Oklahoma and Kansas had only a single report (Speheger et al., 2001). While it's nice to have multiple reports of a single event, it's not always possible.

Are there any non-meteorological factors at play? Highly populated areas are more likely to have people experience impacts than sparsely populated spots. Good spotter reports in rural areas are very valuable during significant events because there are fewer of them.

What time do you have? A report may appear inaccurate because the spotter's time is inaccurate. For fast moving storms, deviations of five minutes or so can be significant. The clocks in our house probably deviate by that much...maybe even more! When comparing reports to radar data, your accuracy is limited to a 4-6 minute window. Some devices, like cell phones, regularly synchronize their time with a standard clock. Comparing these reports to suspicious ones in the same vicinity may help identify poor times in reports.

Using Social Media for Spotter Reports



- Tweets can provide useful info during event
- Use filters to focus attention on trusted sources
- Retweets may cause extra work if relying on hashtags to filter



- Can help spread the word before significant weather
- Most helpful with reports after an event

Info direct from original source still the best, even when using social media!

Social media has become a significant tool for NWS forecast offices to collect storm reports during severe and winter weather. These tools can require a level of monitoring that may make their use seem counterproductive at times. The key is to use them wisely.

Tweets can come in very handy during an event. The problem is that you can end up with way too many tweets that may or may not be useful. However, if you filter your tweets (say using an application like TweetDeck or HootSuite) so that you focus your attention on tweets from trusted sources, that can help a lot. If you rely on using hashtags to filter tweets, such as #ALTornadoOutbreak, you may run into problems from people who re-tweet others.

Facebook is different from Twitter in that it may be more cost effective (at least in terms of staffing) before and after a severe weather event. Facebook, along with Twitter, can help spread the word ahead of time before an impending event. It can generate word of mouth quickly and cause people to mobilize in ways you hadn't imagined. Facebook can also be very helpful after an event. People who are directly impacted by severe or winter weather will often post photos to Facebook about impacts to their life and property. These can be excellent sources of verification, especially since the photo can be tied back to an individual account.

Regardless of the social media tool you use, it's still best to get spotter information from the original source. Re-tweets and post "likes" don't necessarily change the message like in the game of telephone. However, it can be difficult to contact the source of a photo, tweet, or wall post if it has been passed on from person to person. And it's always good to confirm the context of a slam dunk verification photo, even if it seems legitimate.

In Summary: Mitigating Potential Errors in Spotter Reports

- Data quality varies depending on source
 - NWS trained spotters
 - Other experienced spotters
 - Media
 - General public
- Several situations where reports can go bad were presented
 - Observing nocturnal tornadoes
 - Tornado locations
 - Accurate hail sizes
 - Lack of wind damage details
 - Climatological vs. real-time snow observations
- Basic QC steps helps mitigate most common problems
 - Good SA
 - Use radar & other data to verify times and locations
 - Record report source & whether information is 1st or 2nd hand

The quality of information we receive from spotters depends significantly on the observation source. The data source depends on both the person who made the report and how you receive that information. Any single report can be good or poor. Over the long haul, reports should trend toward the generalizations presented here.

To assist in your future error mitigation efforts, several common situations were presented as examples. Several simple mitigations steps were provided, including some basic questions to ponder when analyzing spotter reports that you receive. Your office may have some local policies as well to help mitigate impacts of erroneous reports. Now is as good time a time as any to review your local policies to make sure you understand them. After all, poor spotter information is a single destination, but there are many ways to get there.

Which one of the following sources of ground truth observations are most adversely impacted at night?

- Cloud features and terrain reports
- Radar reports
- Radar measurements
- Radar measurements

AWOC Core, IC4, Lesson1 - Mitigating Errors in Spotter Report...

Quiz - 3 questions

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Questions???

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2. If you need additional help, send an e-mail to iccore4@wdtb.noaa.gov (Instructors group – answers will be CC'd to the SOO and considered for the FAQ page)

Take test ASAP after completing all lessons in this IC

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